Cryogenic Fluid Management for the Aerospace Industry Technology Program

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The solar thermal propulsion concept requires that a number of technologies be matured prior to undertaking full-scale development including the subcritical liquid hydrogen (LH_2) storage/feed system. MSFC is participating with an Aerospace Industry Technology Program (AITP) consortium in the design and performance testing of a 2 m^3 LH_2 storage/feed system for the solar thermal upper stage demonstrator (STUSTD) program. Elements included are: Zero gravity venting, capillary screen liquid acquisition device (LAD), pressurization/expulsion, and multilayer insulation. Basically, the propellant management subsystem concept consists of utilizing the LAD and thermodynamic vent system (TVS) to flow 100 percent vapor to the thruster during burn cycles, i.e., the insulation is configured to match the LH_2 boiloff with the thruster flowrate and mission burn cycle (typically 100 to 200 burns).

The multilayer insulation (MLI) consists of 100 layers of double-aluminized Kapton with B4A Dacron net spacers to achieve a predicted total heat leak of (20.5 Btu/hr). The TVS includes an active mixer to assure a homogenous distribution of the thermal energy within the propellant and a Joule-Thompson (J-T) expansion valve. The cold fluid from the J-T valve flows through tubing brazed into the apex of the LAD, thereby assuring subcooling both the LAD liquid and bulk liquid. The LAD consists of four channels spaced at 90 degrees around the tank, with each leg about 1.6 m in length. The LAD/TVS subsystem is designed to feed 0.9 kg/hr (2 lb/hr) to the thruster at 172 kPa (25 psia). Testing will first be conducted to establish the baseline thermal performance (heat leak/LH_2 boiloff) for the MLI system. The LH_2 feed system will then be operated to simulate a 30-day mission with 140 burns (vent cycles). The test article assembly is complete and ambient leak checking has been conducted in preparation for installation and testing in the 66 m (20 ft) vacuum chamber at test position 301. Testing is expected to be conducted late 1996 through early 1997.

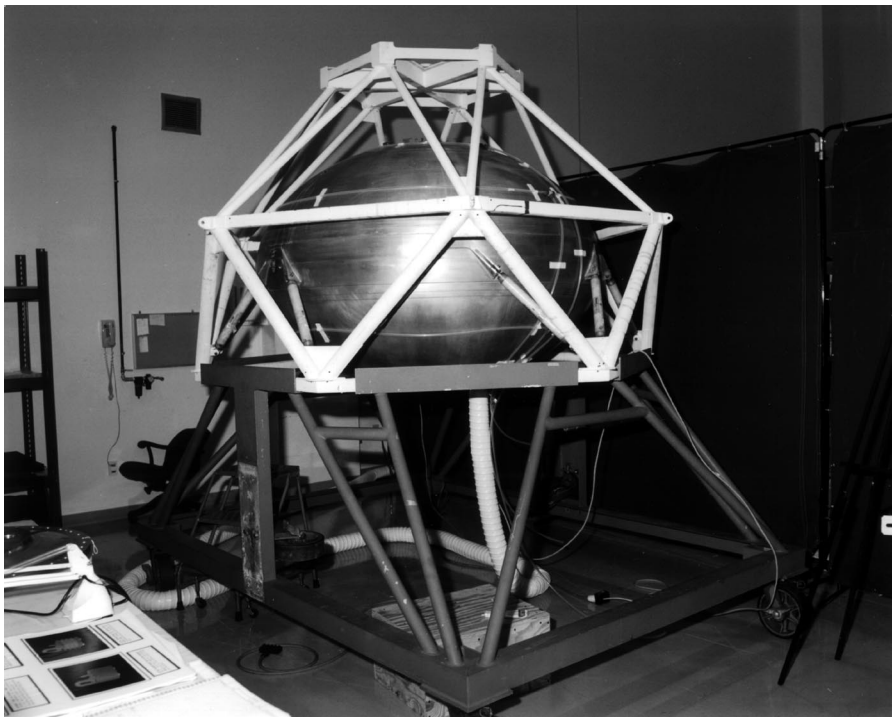

FIGURE 38.—AITP cryogenic fluid management subsystem tank.

Sponsor: Office of Aeronautics

Biographical Sketch: Leon Hastings, currently assigned to the MSFC Propulsion Laboratory, received his B.S. in mechanical engineering and an M.S. in engineering science. Assignments at MSFC since 1961 have centered on heat transfer, fluid mechanics, and thermodynamics, and he has over 15 years of specialized experience in low-gravity fluid management and heat transfer. He has often served on Agency-level committees to assist in formulating plans/policies for low-gravity propellant management research and technology.